

**Electromagnetic device for heating metal elements**

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**Abstract**

A magnetic field heating device for heating metal including a means to create an alternating magnetic field passing this magnetic field through a dissimilar metal part to uniformly heat the part. This differs from induction heating of metal parts because the part is heated uniformly rather than being restricted to the skin or outside portions of the part. This unique heating is accomplished by utilizing a novel magnetic loop for

creating a high density alternating magnetic field in the metal part to be heated. 

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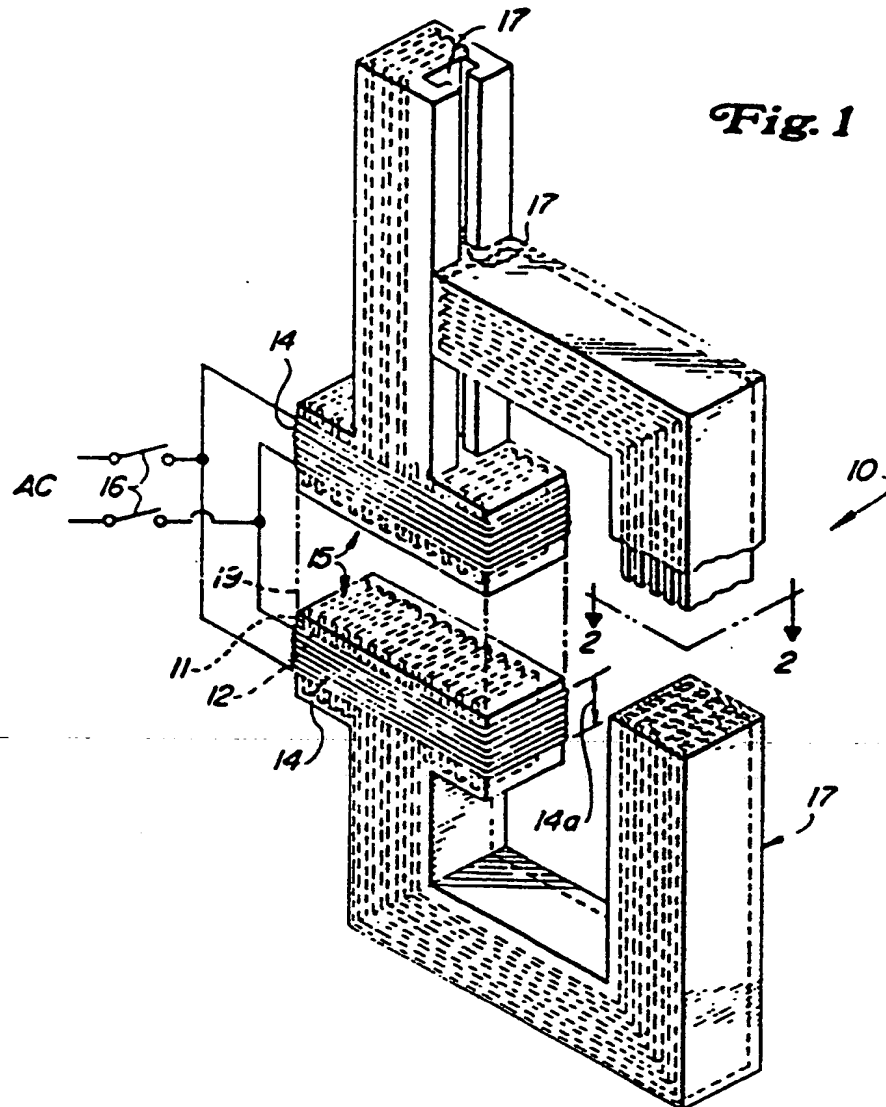
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**(54)** **Electromagnetic device for heating metal elements.**

**(57)** A magnetic field heating device for heating metal including a means to create an alternating magnetic field passing this magnetic field through a dissimilar metal part to uniformly heat the part. This differs from induction heating of metal parts because the part is heated uniformly rather than being restricted to the skin or outside portions of the part. This unique heating is accomplished by utilizing a novel magnetic loop for creating a high density alternating magnetic field in the metal part to be heated.

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**Fig. 1**



## Background of the Invention

This invention relates to a novel method for heating metallic parts.

It has been known that there are only a few basic mechanisms systems or methods for creating heat in a metallic part. Convection heating can be used which may include direct flame, immersion, radiation, electrical resistance where the heating of the metal is caused by the flow of the electricity and heat may be created by mechanical tresses or friction. Included among these has been induction heating where the heating is caused by use of magnetic fields. As is well known in the induction heating art, a metal workpiece is placed in a coil supplied with alternating current and the workpiece and the coil are linked by a magnetic field so that an induced current is present in the metal. This induced current heats the metal because of resistive losses similar to any electrical resistance heating. The coil normally becomes heated and must be cooled in order to make the heating of the workpiece as effective as possible. The density of the induced current is greatest at the surface of the workpiece and reduces as the distance from the surface increases. This phenomenon is known as the skin effect and is important because it is only within this depth that the majority of the total energy is induced and is available for heating. Typical maximum skin depths are three to four inches for low frequency applications. In all induction heating applications, the heating begins at the surface due to the eddy currents and conduction carries heat into the body of the workpiece. Another method of heating metal parts using magnetic fields is called transfer flux heating. This method is commonly used in heating relatively thin strips of metal and transfers flux heat by a rearrangement of the induction coils so that the magnetic flux passes through the workpiece at right angles to the workpiece rather than around the workpiece as in normal induction heating. Magnetic flux passing through the workpiece induces flux lines to circulate in the plane of the strip and this results in the same eddy current loss and heating of the workpiece.

Another method of induction heating utilizing direct current is described in an article by Glen R. Moore in the Industrial Heating Magazine of May, 1990, page 24. In this new heating method, direct current is utilized and the current flows in the axial direction of the workpiece because of the rotation of the workpiece rather than the rotation of the field about the workpiece. This method is also describe as being able to heat a slab of metal which is the DC method of transfer flux heating. This method also utilizes a skin effect and a method of determining the penetration for a direct current field as is described in the article.

However, none of these heating systems provides for the uniform heating of a workpiece without

conduction changes from the outside either in a magnetic field or in the direct flame method or related methods.

Therefore, it is desirable to make use of this novel magnetic field technology to overcome the disadvantages of the prior art as well as improving the efficiency of heating a workpiece uniformly throughout its cross-section.

## Summary of the Invention

An object of the present invention is to provide a method of uniformly heating a metal workpiece throughout both its cross-section and length. It is another object of this invention to accomplish such heating with a minimum the loss of heat in the coils and in the skin effect of the part and without utilizing conduction. These and other objects of the invention are accomplished by a novel magnetic field system which permits, indeed, accomplishes the uniform heating of any metal part placed in the magnetic field generated by this novel system. The magnetic field is generated by a magnetic loop including a plurality of thin plates also includes an air gap into which the workpiece can be placed. The workpiece then is included and becomes a part of the magnetic loop. The magnetic field generated by the system passes through the workpiece as it does the remainder of the loop. This magnetic system works best at 50 to 60 cycles; however, this means that the system can use normal electrical power delivered by an available outlet in all commercial installations.

The invention also will heat uniformly non-magnetic metals which are placed in the air gap of the magnetic loop. Numerous tests have been conducted that show that the entire cross-section of regular and irregular parts can be brought uniformly up to the desired temperature with a very rapid heating for these parts.

## Description of the Drawings

Fig. 1 is an illustration of the novel magnetic system of this invention.

Fig. 2 is a cross-sectional view of Fig. 1 at 2-2 showing the details of the laminations.

## Detailed Description of a Preferred

## Embodiment of the Invention

As seen in Fig. 1 a magnetic loop system is 10 shown. This magnetic loop 10 consists of a plurality of metal strips 11 formed into a magnetic loop laminated structure. Magnetic strips 11 are high permeability silicon steel in a preferred embodiment although any high permeability material may be used. Metal strips 11 have insulation 12 attached or